Just Imagine Financial Planning Software That Does This

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Abstract:

Very little research has been done on strategic financial planning software programming. Today's approach is to perform a single simulation, calculation, or utility application and assume the results apply to all times and allocations for all future ages. But time periods change with age as do allocation characteristics over time. This paper steps back to look at financial planning software programming as a foundational strategy to model retirement income while aging that same retiree over time, meaning looking at all the possible future time periods as well as all prudent allocations over those possible future time periods. Additionally, research to date has focused on "early stage" retirement meaning the retirement event occurs sometime in the retiree's age-60's. In other words, the inception of retirement. Little research has been done looking at the transition into later stage ages or later allocations for portfolio income distributions through "late stage" retirement years. It is not enough to know how to initiate retirement. It is also necessary to know how to sustain retirement spending prudently, as well as how spending decisions ripple through age to future bequest balances. This paper reviews concepts on how to imagine that transition to and through late-stage retirement and develop better software programming using a data cloud concept to accomplish that early-to-late stage retirement income modeling based on research evidence.

Introduction

Financial planning software today is still a calculation-based approach that derives a supposed solution that most in the profession call a plan. Under the current paradigm, there is much more to be desired. Those desires are currently limited by the perspectives and interests within the software provider community that is also driven by the demands from the profession also unaware of what may be, as compared to what is. This phenomenon is a form of group think. Advisers are unaware of what may be, so they can't ask the software profession to develop and provide something neither group is aware of, or even thinking of.

From the perspective coming from the author's approaching three decades in the profession as a practitioner with more than half that time also as a published researcher (*Journal of Financial Planning* (Google Scholar) with working papers posted on SSRN) puzzling over what makes retirement income simulations and modeling tick, the author doesn't see the advances in approach and application in the financial planning profession and software programming that is seen from advances in other professions and the sciences over the same time period. Innovation in thought and application is slower in the planning profession which may be due in no small part to the emphasis on software development, and the profession, focused on the sale of

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products, rather than an emphasis on models that support planning, advising and retiree decision making.

Neither group seeks out other information from other disciplines either, as explained below.

Maybe a bit critical, but perhaps some will see what may be possible through the lens of small paradigm shifts (paradigms discussed in SSRN paper titled "What are the Three Paradigms of Retirement Income Planning" (Frank, 2022) that come from the application of some key capabilities and insights from other professions. Capabilities and insights that would move the profession from simple calculations (what most now call simulations by applying Monte Carlo, or stochastic processes) to modeling the process of aging for retirement planning income purposes, both before and after retirement, and with a seamless transition between working years and retirement year (and within those retirement years as well) based on using the same modeling "imagines" described below. In other words, a unified model based on age.

This topic is not a matter of opinion as some may believe. It is a matter of disciplined experimentation involving control values so results can be meaningfully compared, contrasted, evaluated, and duplicated. Experimentation with control variables to test and prove or disprove hypotheses comes from the application of the scientific method. Each of the below "imagines" are testable (most already have been tested and published), and all can be combined into one model that has yet to be developed. Experimentation is how science, based on evidence, works.

The current paradigm is a continuation of the past deterministic approach in thought and concept, only with a Monte Carlo overlay where each simulation is cast over a single period, most commonly 30 years. The contrast between today's Monte Carlo, or stochastic, computation is comparable to the deterministic computations utilized prior to Monte Carlo applications as shown in Figure 1.

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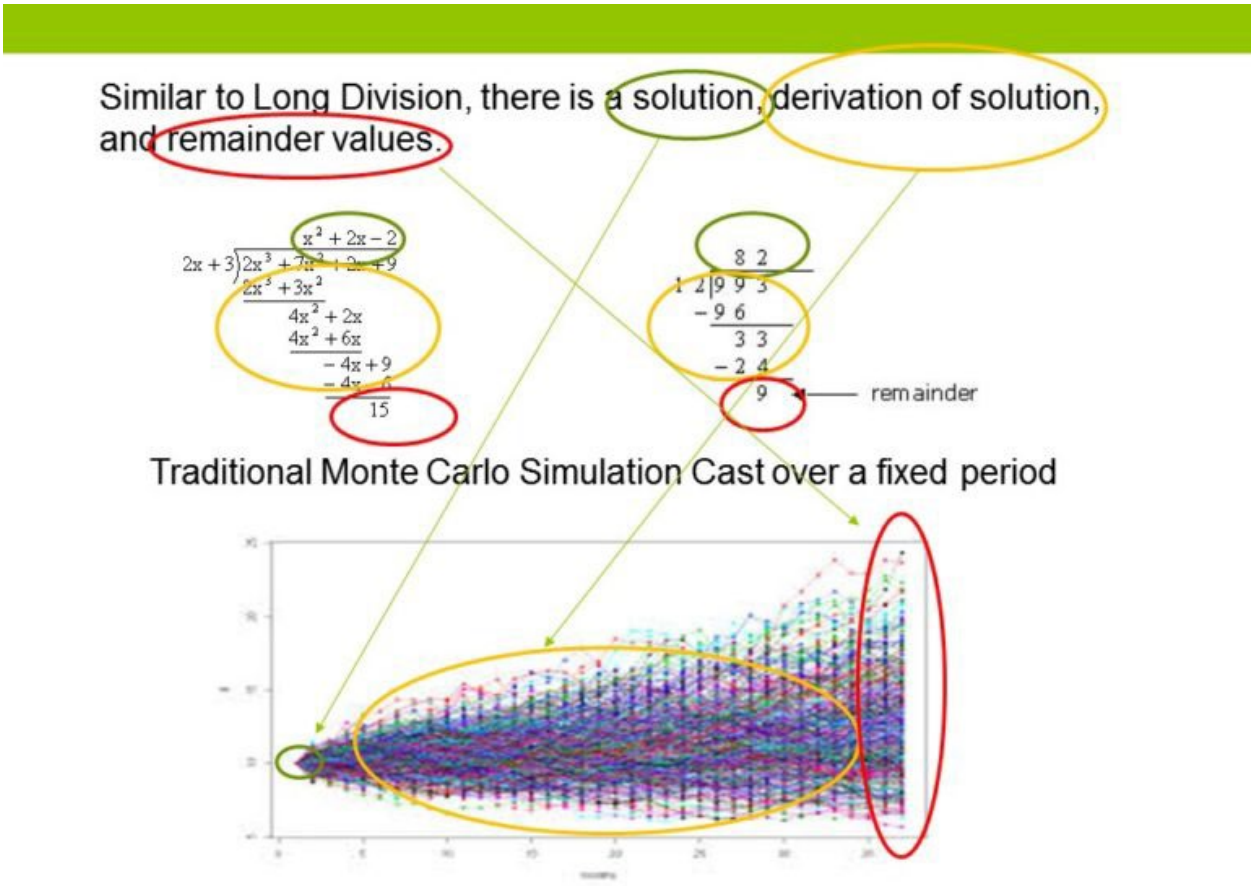
Similar to Long Division, there is a solution, derivation of solution, and remainder values.
remainder
Traditional Monte Carlo Simulation Cast over a fixed period

Figure 1. Traditional Deterministic computation compared to a Monte Carlo simulation.

What about other time periods? What about other efficient allocations? How do all of these compare to each other? At what ages should allocation change? This single simulation, *and* single calculation, approaches creates an illusion of modeling. Each and every time current paradigm software runs, it performs redundant calculations for the same single time period as well as the same allocation, that with a small paradigm shift, need only be performed once and captured as explained in the SIPMath segment below (SIPMath is a process that captures auditable data).

> Auditable data: Each simulation should contain a sufficient number of iterations such that a repetition of that same simulation would produce statistically similar iteration results when iteration percentiles are compared. Also, a sufficient number of iterations such that differences between each iteration percentile produces meaningfully different results between iteration percentiles, e.g., 60th percentiles, 50th percentiles, 40th percentiles, or any XXth percentile; for specifically the end of year one (1) percentile values for cash

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flows and portfolio balances for uses "imagined" below. Note that later simulation percentiles fall within a greater dispersion of earlier simulation percentiles as depicted simplistically in Figure 2. This is referred to as a strategic use of simulation percentiles where serially connecting each simulation's "end of year one" XXth percentiles (top of red bars, and bottom of red bars) together results in a more focused age-based sequence of a *range* of statistical cash flows and portfolio values outcomes withing those percentile selections. This serial connection is seen in Figure 6. Cash flow ranges scale proportionally to serially connected portfolio balances directly related through the drawdown rate calculated by age. The Cash Flow WITHIN a single fixed time period, as derived from a "rule of thumb" approach to longevity, Monte Carlo calculation is NOT the same as Cash Flow BETWEEN a connected series of Monte Carlos calculations with decreasing time periods that model aging (time periods come directly from a STRATEGIC use of longevity period life tables).

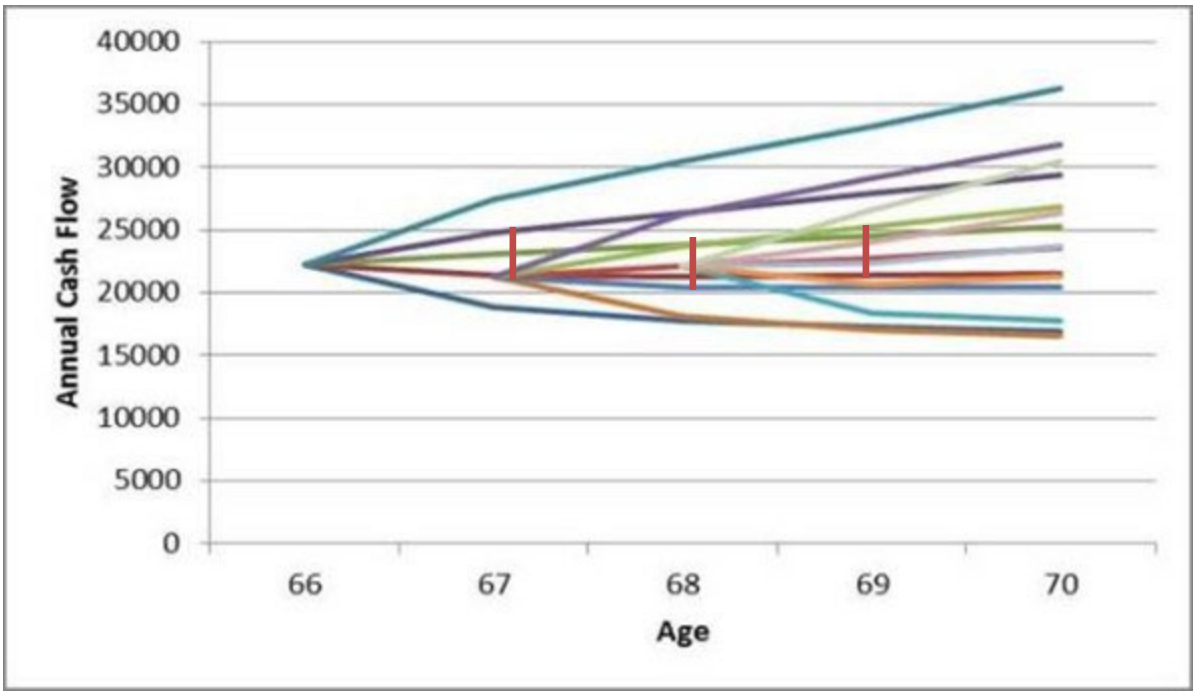

Figure 2. How simulation percentiles of later simulations fall within those of earlier simulations.

Finally, also with a sufficient number of iterations to produce discernible draw down rate results down to at least two decimal places, which allows for visible differences between asset allocation results *by age*, and visible differences between draw down rates *by age* as well (where "age" is represented by differing time periods of simulations). Yes, such precision is possible

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when evaluating simulation iteration percentiles at the end of year one in simulations; and comparable between different simulations for both allocation differences as well as time period differences, when the iteration failure rate (IFR) is held constant as the control variable. This as opposed to today's inaccurate label of Probability of Failure (POF) where POF is not held constant but instead "floats" between various values perceived to be "acceptable" in the profession. The scientific method utilizes control variables so that different outcomes may directly comparable to each other. Draw down rates form a three dimensional "data cloud" (Frank, Larry R., John B. Mitchell, and David M. Blanchett. 2012a.) where age (time), allocation characteristics, iteration failure rate (commonly understood under the present paradigm as probability/possibility of failure), all derive the draw down rate (also called withdrawal rate). See Figure 3 for an early example of such a data cloud. Both Figures in Figure 3 below are from Frank, et al, 2012a labeled Figure 1 and Figure 2 in that published paper.

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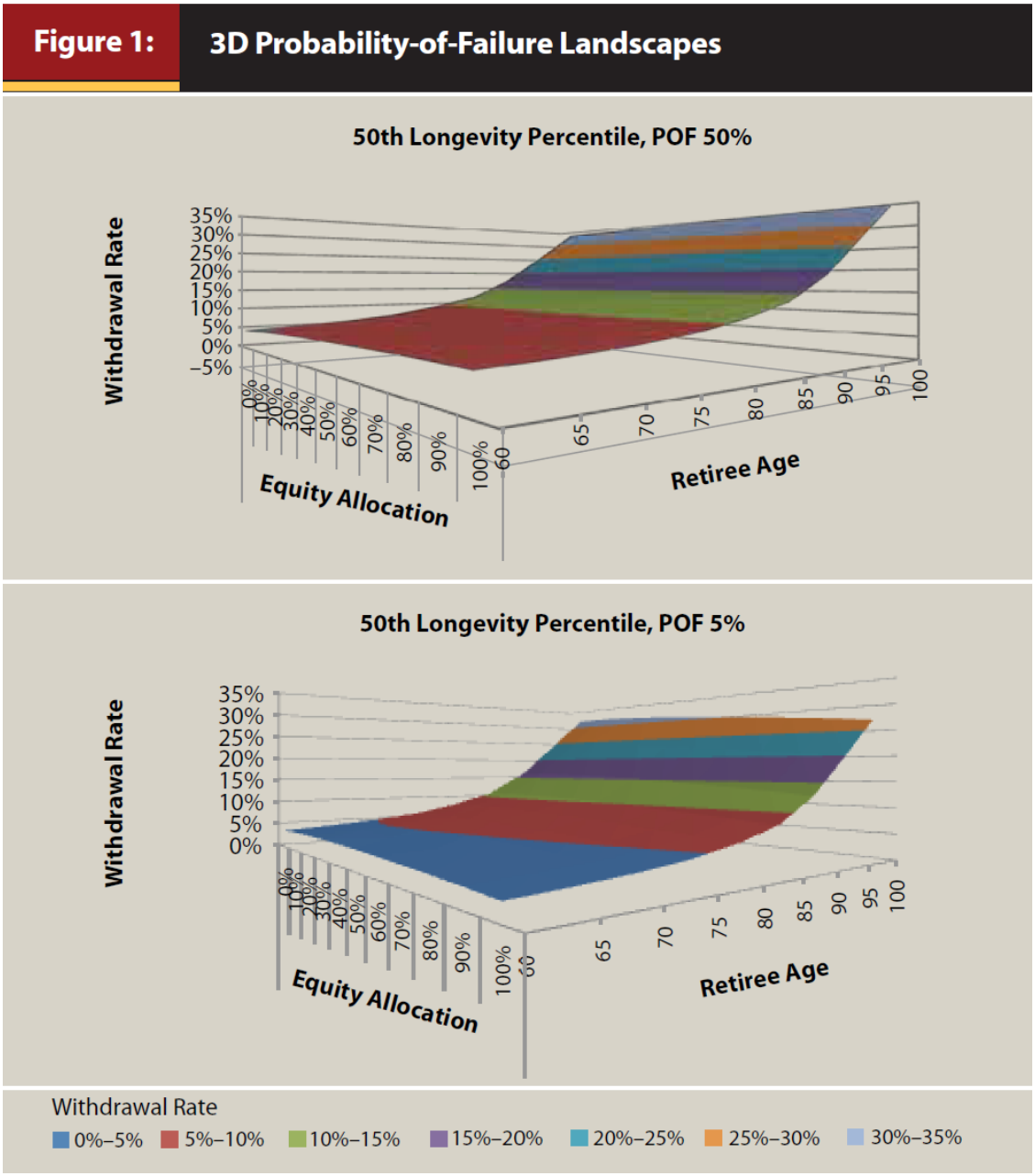

Upper panel of this paper's Figure 3 (labeled below lower panel next).

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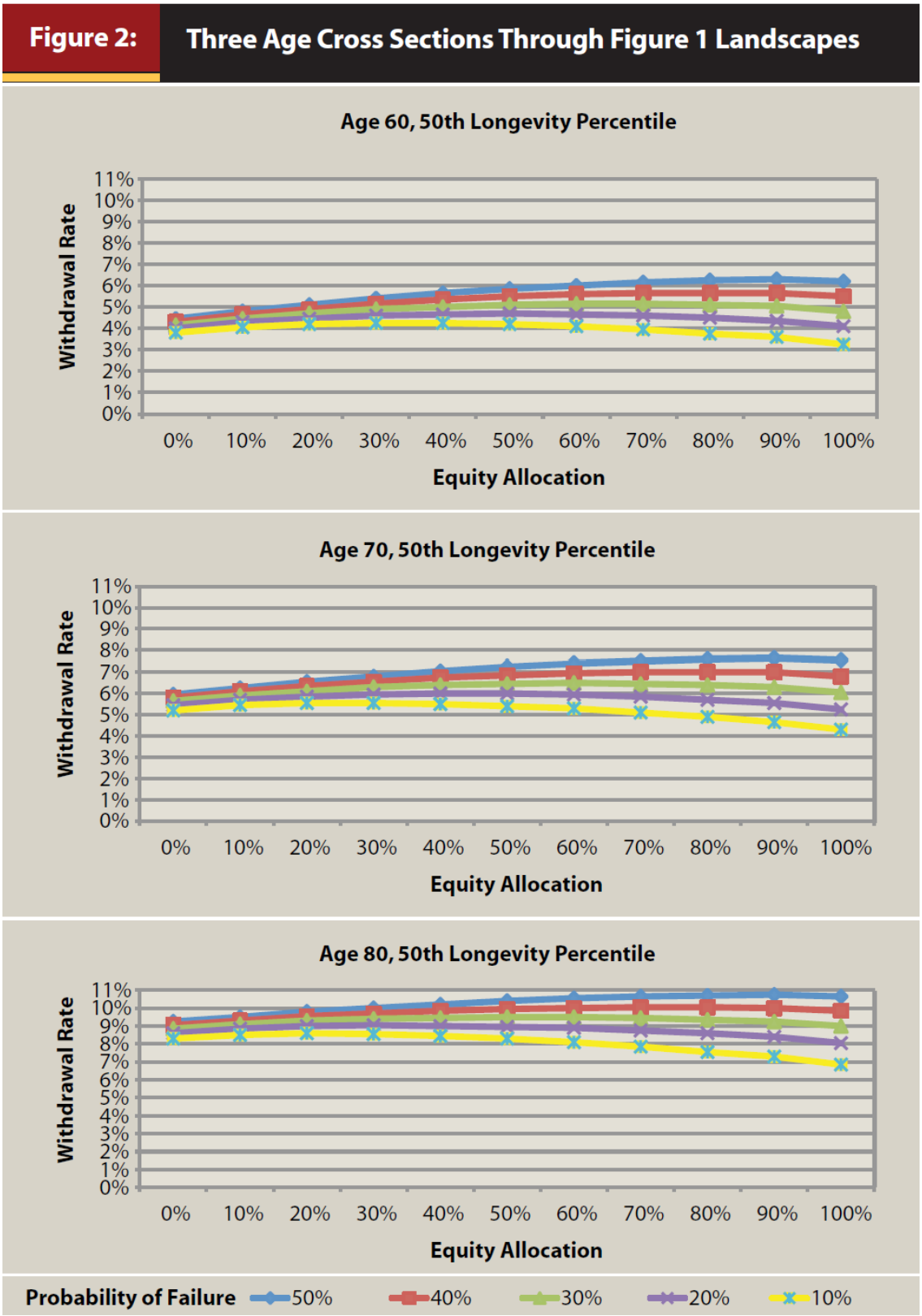

Figure 3. Example of a 3-D "data cloud" and cross sections (Figures "1" and "2" from Frank, et al, 2012a)

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The 3D nature of retirement income withdrawals from portfolios over time and allocation was duplicated and confirmed through a completely different methodology in Suarez, E. Dante. 2020, Figure 26.

Modeling software should be programmed to optimize the drawdown, by using the "data cloud" to simultaneously compare alternative efficient allocations at the present and *all future ages* too. Present software requires a hunt and peck approach to compare allocation choices, not only at the present age of the retiree, but at any future age as well. Not only this, but the connection between today's age and any future age is missing for both cash flows and portfolio balances after fees. Today's approach is simply *one data point* among many other allocation possibilities for present retiree age, with no data points available for decision making for future ages. This is akin to deciding to choose only one data point from Figure 3 above to make spending decisions over the remainder of the retiree's life based on that single point in time (age and allocation make that one data point in 3-D space).

Additionally, there is no consistent use of life tables to determine a more statistical use of longevity data, and strategic use of longevity percentiles (Frank, Larry R., John B. Mitchell, and David M. Blanchett. 2012b), in determining a statistically determined "end" age for each attained age in the first place. A data cloud would compile data once and be able to be used often (Run Once Use Often) with annual updates to the data and thus the data cloud.

Use of a strategic use of longevity life table percentiles adjusts the exponential nature of drawdown rates due to ever shorter distribution periods. This can be seen in IRS Required Minimum Distribution (RMD) tables. It was also seen in work by Frank, et al, 2012b where the contrast between unadjusted for exponential results were compared to an adjustment for these exponential effects of ever-shorter distribution periods. See Figure 4.

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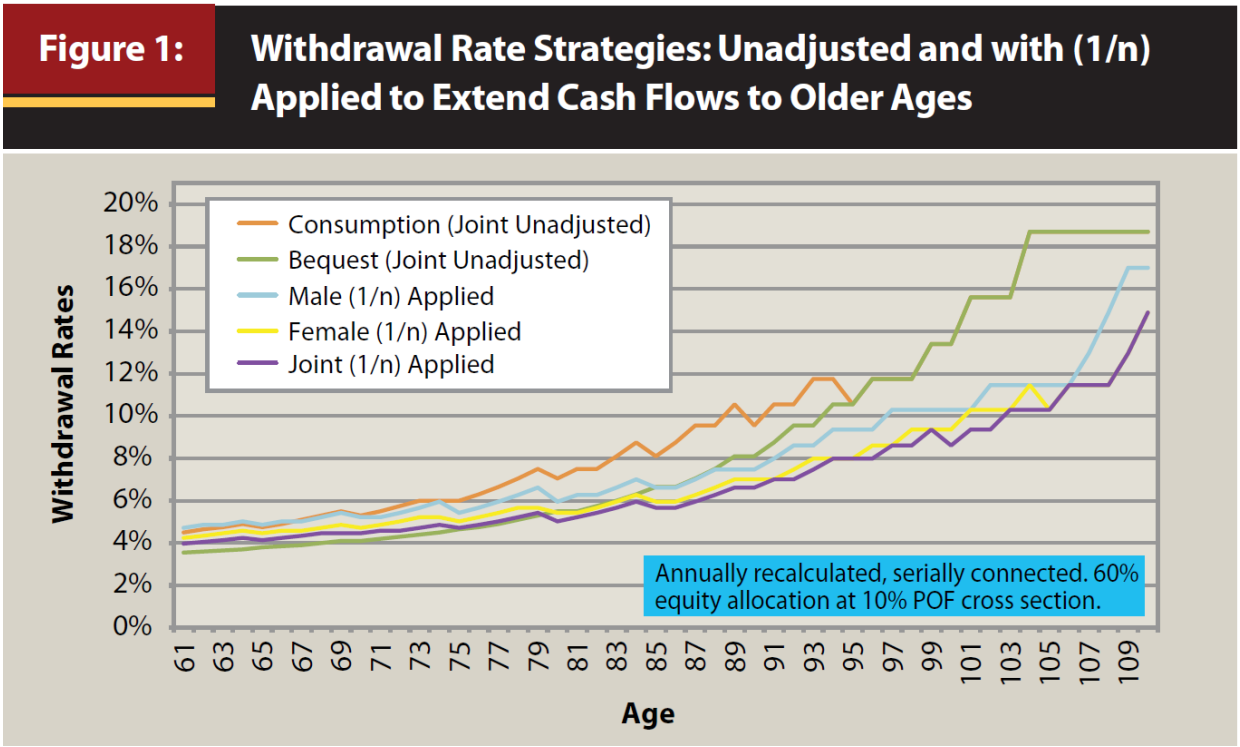

Figure 4. Both a longevity adjustment vs a distribution period adjustment (exponentiality) of 1-1/n. Note the label "Figure 1" from Frank, et al, 2012b label Figure 1 in that published paper.

It is known that spending early influences balances later (legacy or bequest values). There's an implicit choice people make if they choose to spend more than prudent (lower bequest) or spend less (higher bequest). People can't see that implicit choice when "age to age" calculations are performed one by one, one year at a time. This is not seen because the cash flows and balances WITHIN a simulation are NOT THE SAME as cash flows and balances BETWEEN simulations. The latter is a model where deeper insights are made.

On the topic of legacy. There's a mental trick that is played on our brains in early retirement where the potential bequest appears large. It appears large because some of the money, I'll call it "principal," isn't really bequest money – it's lifestyle spending money for later years. As one ages, the principal needed decreases, because there are fewer years remaining that need lifestyle spending. The bequest amount is only really visualized when it is separated either by math (subtract it out in modeling), or by account where that account is not included in the modeling. Both approaches lead to the same results; only the latter being where the bequest can be clearly "seen" on statements and reports. Modeling the interplay over time between lifestyle today for

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the retiree, versus bequest for others makes this much clearer than single computations done year by year as one ages.

The reader may think that the IRS RMD does what the author suggests in this paper. The IRS RMD approach does result in drawdown rates based on age and does have the advantage of being independent of allocation characteristics, thus making it easy to apply to any retiree. However, the RMD rates are "raw" rates not adjusted by observations and adjustments made in Frank, et al, 2012b. The cons of this approach is that the portfolio is never optimized for an efficient frontier allocation and thus also not optimized for income drawdown either because the portfolio is not working as hard as it could. See Figure 5. Figure 5 also shows how optimized portfolio drawdown rates allow for greater spending relative to RMD tables in the early years. But, IRS RMD tables also forces more taxation in the later years (because of that unadjusted exponential effect (which is adjusted by 1- 1/n where n is the longevity percentile strategically determined distribution period). The unaware are thus spending more than they should spend in those later years. Yes, they're required to withdraw a given amount to pay taxes, but they are not required to spend it all, and shouldn't (they should reinvest the calculated unspent portion), based on longevity percentile considerations where they may outlive the non-strategical longevity percentile taken from the IRS tables, i.e., "raw", determined time frame determined from the IRS RMD tables.

Note also that Figure 5 shows an example of a "data cloud" with separately calculated drawdown rates by age and portfolio allocations. Software could lookup the optimal drawdown rate by age and allocation with such a data cloud pre-programmed in.

It is well known that longer duration leads to lower drawdown rates. So, the question is, when do those longer, versus shorter, durations apply?

If one arranges data output on graphs based on age, i.e., putting their age on the x-axis representing the time function, it changes the perception as to how to arrange the data. That is Age(s) (e.g., 67, 68, … 70 … 75 … etc.), instead of number of year (e.g., 1, 2, 3 … 5 … 10 … 15 … etc. *since or from retirement*). An important, but subtle, shift in perception and paradigm.

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In other words, do longer durations apply at the END of the data stream (and thus influence our graphical depiction and thus interpretation, of the data as displayed)? This is how data and graphs are depicted presently and is an extension of our human minds wanting to count the years up … "years since" or "year in" retirement, or "years of" or "duration of" retirement. All examples of counting the years up.

Or alternatively, do longer durations apply at the BEGINNING of the data stream (and thus influence our graphical depiction and thus interpretation, of the data as displayed)? When an age-based approach is applied by using life tables statistics to derive the time frame, this results in data being graphed and depicted with longer terms at the beginning of the graph or data tables, rather than longer terms at the end … as one ages into shorter terms over time. The ah-ha comes from seeing ages and data aligned together graphically and in data tables. Drawdown rates and age-based longevity are data sensitive.

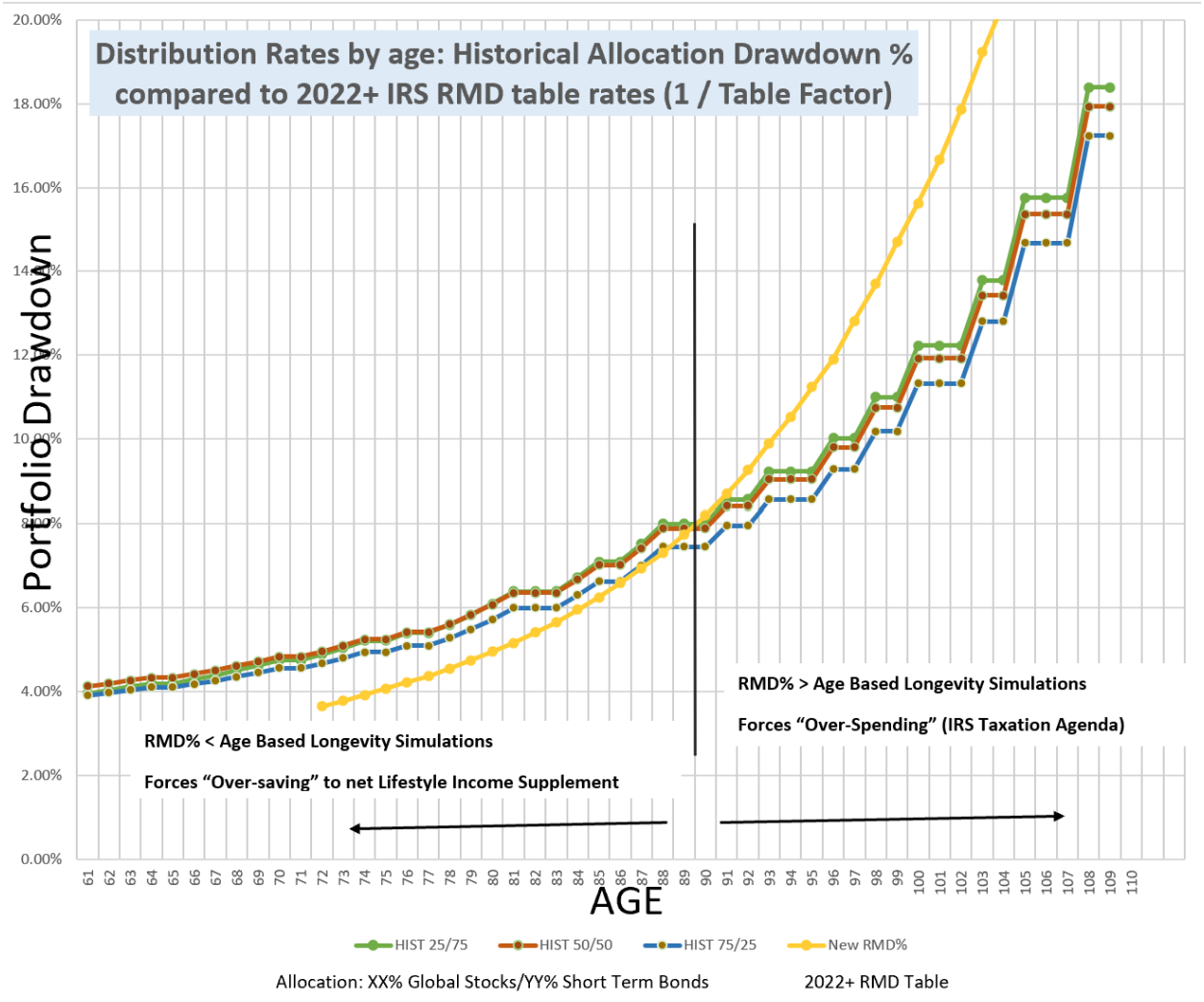

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Figure 5. Comparison of IRS RMD 2022+ Distributions with Longevity & 1-1/n Adjustments to "Raw" Drawdown rates.

The hunt and peck approach (one data point at a time per simulation) to planning is long overdue for improvement, note that the exponential effect of "raw" rates were noticed and address in 2012 (Frank, et al).

As a result, draw down precision is currently missing in the present paradigm, especially to two or more decimal places. Rather, still in use, are rule of thumb approaches that have little connection to rigorous scientific calculative approaches, especially based on one data point selected from the data cloud. Draw down precision allows for strategic use of iteration failure rates, contrasting 10% versus 25% iteration failure rate data clouds for example, which can then be used for *pre-calculated* decision rules that are specific to present portfolio values and allocation characteristics, to develop a Distribution Policy Statement (DiPS) updated annually. The 25% data cloud would signal a target portfolio balance to trigger a spending retrenchment suggestion, as well as to what specific spending level (cash flow) is then suggested. (Frank, Larry R., John B. Mitchell, and David M. Blanchett, 2011). A rising iteration failure rate signals increased risk of over-spending because it means, given a fixed spending amount in dollars, and falling portfolio balances due to declining markets, that the drawdown rate has risen from declining markets. The positive correlation between high (low) drawdown rate and high (low) iteration failure rate is well known.

Clinical application of this approach shows that spending retrenchment is often less than imagined or feared *and* is often an automatic behavioral reaction of retirees clinically evidenced in both the 2008 and 2020 market and economic downturn episodes. A DiPS should address the behavioral aspects of retirement, supported by both process and structure, for the whole of the present year, computed *in advance at the beginning of each year,* to address *what* do you *do*, *when* portfolios values reach $X, $Y, and $Z dollar values (beyond simply "stay invested" and "cut spending," though those are behavioral steps too – but *when* and *why* supported by computations, read simulations, of specific portfolio balances for the year in advance is what is lacking. Modeling should automatically address this to produce a DiPS document.

This present-day redundant calculation approach is quite different from the approach with a complete adoption of Monte Carlo that is cast over rolling time periods whose lengths are all different and that incorporates all of the "imagines" below as well. Processing resources could be

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better used for modeling as imagined below, rather than to perform redundant calculations each time a simulation is run with differing inputs for allocation and/or age. Retirement is not a single set period of time as viewed from the current static paradigm. Retirement is actually a connected series of statistically determined time periods over an ever-shortening period of time as viewed from a dynamic three-dimensional paradigm as explained below.

Note that joint life tables result in lower drawdown rates, female rates are slightly higher, and male rates are higher still, all due to differences in drawdown time periods in the longevity tables. Use of longevity tables as applied here are described in Blanchett and Blanchett, 2008 and Mitchell, 2010.

Below is a discussion for a paradigm shift with sidebars and postscripts following for further thought.

Literature Review

There is little research on the *combination* of both retirement income planning and software programming to support that planning. By planning, the author means through the paradigm lens as described above which addresses the shortcomings of the current paradigm. A subsequent working paper will be posted on SSRN titled "What are the Three Paradigms of Retirement Income Planning?" (Frank, 2022). Research literature is incorporated into this paper at different points that brings in research of various components of the discussion.

The "Imagines …"

Here are a few "imagines" of incorporating other sciences (illustration follows):

1. Imagine software that would suggest what model allocation one should have based on your current age, and not only that, but model at what ages a retiree should consider changing that allocation as well. What allocation is optimal based on present age, relative to other efficient model allocations choices? This, as compared to inputting as is now currently done with an allocation that carries through the whole single simulation process – then "hunt and peck" contrasting alternative allocations, none of which adopt allocation changes for later ages.
2. Imagine software that can compare your current allocation results (I'll call "inefficient"), to model portfolio allocation results (presumably models that are optimized for efficiency) over your lifetime regardless of how old you may get, so you may be able to make decisions as a retiree of what allocation is optimal at each and every age looking

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forward. Efficient model portfolios only need to be simulated once and that output captured to form a "data cloud" from which those solutions are looked up and incorporated into the model. Example in Appendix 1. Drawdown rates depends on certain set factors which are already established by using efficient model portfolios as well as strategic use of the other factor inputs. These factors are: 1) portfolio statistical characteristics (ideally metalogged – discussed below, points 5 & 6) that don't change until dynamically updated periodically, say annually, since they're efficient models by definition. 2) length of time the simulation is run over that is determined by current age to longevity table determined end age (the difference in years between derived table end age and present retiree age(s)). By the way, longevity tables also have percentile statistics that can be strategically used to slowly increase the table age where fewer and fewer survive past; a rolling adjustment of that surviving age percentile which slowly extends the spending time frame to reduce possibility of outliving portfolios (excluding catastrophic spending which can't be predicted). 3) Iteration failure rate which standardizes the output of simulations for apples-to-apples comparison when the same iteration failure rate is used to develop the "data cloud." It takes the three dimensions just discussed above to derive the intersecting fourth point (the "answer"). In other words, a three-dimensional model making up the data cloud comprised of all those "fourth point" solutions from which to compare and contrast solutions based on optimal solutions and desired retiree outcomes. How can anyone provide a computational answer under the current paradigm when each of the three dimensions above are only loosely defined by rules of thumbs (e.g., 4% rule, 60/40 allocation, age 95, or variations thereof)? The answer is discussed in the professionalization postscript below.

3. A "data cloud" consists of all of the compiled answers and auditable data of each and every simulation run for all of the different allocations and all of the different time frames. Software then looks up the optimal solution between allocation data points corresponding to each time frame, where the time frame is derived from longevity tables (longevity table percentile end age minus each attained age modeled). There is no need to re-simulate solutions since they have already been done and archived in the data cloud for subsequent use in each cash flow model run. It makes little sense to continually simulate something, using processing power, that can be done once with an auditable process that can be reused as often as needed, thus saving processing power for expanding modeling capability. All the statistical data sets may be updated and simulation solution sets captured annually. Only inefficient, non- model, allocations would need to have their solutions simulated and captured for inclusion in the modeling software, for comparison to results of the efficient models to make better decisions from a model output comparison.
4. Imagine software that actually used longevity statistics based on each and every age one would live through, even to the end of the longevity table used; though unlikely most would live that long, it's possible a small number might. However, dynamically adjusting longevity with age is a strategic use of longevity statistics as opposed to using rule of thumb ages. Strategically adjusting longevity percentiles is akin to slowly moving the goal post so fewer and fewer retirees *outlive* a pre-determined, strategic use of longevity percentiles. For example, longevity percentile use at age 60 may be the "expected longevity" definition of the 50^{th} percentile where 50% *outlive* age 60. Subsequently, adjusting the longevity percentile by 1 percentile by age-year, would result in an age 70

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40th percentile where 40% *outlive* that percentile derived end age for 70-year-olds; age 80 30th percentile where 30% *outlive* that percentile derived end age for 80-year-olds.; etc., etc., to age 100 10th percentile where 10% *outlive* that percentile derived end age for 100-year-olds. So, this is an important capability for those who continue to live into older and older ages. This as compared to a rule of thumb of age 95 or 100, or assumed input of any such age. *Why not have the software continue to determine what that end age* should be simply through the application of statistical tables that already exist. *Why guess or assume* when we already know that the *longevity tables change their statistical curve shape as one ages*, and the expected total time frame and duration *continually shorten*. So, model that changing shape based on every age a retiree may reach statistically in the future, through rolling adjustments, within the modeling software itself. The model simulations continue to the end of the life table; however, one may choose to what age they wish to consider *illustrating* ending results, i.e., table end ages, and illustration end ages, don't necessarily need to be the same, with the table end age being the longest time duration. Later results may simply be revealed, without changing any earlier age answers; or vice versa. In other words, under the current paradigm, if you wish to consider a different ending age to simulate to, you change all the answers between current age and ending age too (because the time period for simulation changes)! Interim results shouldn't change unless by design (imagine #8). Draw-down rates slowly increase with age, though at a slower rate than Required Minimum Distributions (RMDs). Draw-down rates can be specifically calculated for each and every age based on the strategic use of life table statistics.

5. Imagine software that actually looked at how retirees, or "real people," adjust their spending as they age (e.g., Bureau of Labor Statistics Consumer Expenditure Survey (BLS CEX)). (Blanchett, 2014).That data has statistical curve shapes (metalogged) that also change over time (i.e., age). Rather than use average spending (Dr Sam Savage: The "Flaw of Averages" (Savage, 2012) and "Chancification: How to Fix the Flaw of Averages" (Savage, 2022), instead incorporate those slow adjustments to spending by age directly into the model. Imagine if a retiree were concerned about medical expenses, then the metalogged data that focuses on the medical expense percentiles by age to place more emphasis on those; or any other expense area(s) of interest or concern as well.
6. Imagine software that uses **new statistical processes called metalogs** to incorporate how statistical data is actually shaped not only overall, but also via time slices so that data may be matched up to each and every age a retiree has and may reach. Statistical data for portfolio characteristics, longevity, and spending can all be better viewed statistically through metalog application to better visualize how all those data types change shape with age (time) and allocation characteristics. Metalogging is a process to fit the statistical curve to the data (skewness, kurtosis, fat tails, lobsided tails, more than one mode, etc.).
7. Imagine software that automatically compares possible cash flows (serially connecting simulation percentiles) from *better than* median markets (e.g., 60th percentiles of serially connected simulation series), median markets (e.g.,, 50th percentiles series), and poorer than median markets (e.g., 40th percentile series) to "stress test" effects on cash flows and balances through continually poor markets; where better than, expected, or poorer than cash flows, and fees, from those respective portfolio balances would be adjusted within the software time series, age by age, by age.

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8. Imagine software that compares different "what-if's" scenarios on an apples-to-apples basis by weighting the sum of what-if scenario cashflows weighted each age by the probability of being alive at each age.
9. Imagine inputting cash flow floors, or ceilings (Frank, Larry R., and Shawn Brayman. 2016) may be incorporated to see how those affect outcomes. [This paper won the CFP® Board Best Research Paper Award at the 2016 Academy of Financial Services annual conference]. "Lumpy" expenses, such as periodic car purchases by lump sum down payments vs. loans, that aren't ongoing can also be inputted and modeled. Using assets to buy an income annuity versus retaining those assets may be easily compared, i.e., what is the comparison of a set amount of assets used to purchase an income versus that same set amount of assets used for supplemental income in the first place … over time *by age?* (Frank, Mitchell, Pfau, 2014). Similarly, incorporating outside assets from a reverse mortgage may be included or excluded for comparison of outcomes. Visual outcomes that retirees may easily see (see solutions graph below). Fama has said many times that models don't predict future results; they aid in decision making. (Models vs predictions: Endnote 1). Retirement income planning requires many considerations for decision making. Software should model how all of the above factors blend together age, by age, by age as a retiree ages … for the purpose of better decision making, not only now, but into the future as well to see how today's decisions, through ripple effects, may affect and influence future desires. How do those decisions "look?" See example illustrations below.
10. Imagine seamlessly incorporating pre-retirement accumulation that incorporates Social Security and/or pension income changes with possible claiming ages to show what actions most affect a *retirement feasibility timeline* showing all those choice alternatives at the same time *by age*, over an age range, e.g., ages 62 to 70 corresponding to Social Security claiming ages, rather than running alternatives one by one by one, resulting in many different unconnected reports. Imagine using Monte Carlo (stochastic modeling) throughout the model, from working age through the end-of-life tables, to seamlessly transition from accumulation to draw down, to bridge the gap between specific family standard of living needs by an age-based draw down rate to determine the total portfolio value needed, by age, to develop such a feasibility timeline; all using the same age-based principles using Monte Carlo processes throughout. In other words, at potential retirement age X, you have $Y dollars from Social Security (and/or possibly a pension), what is the gap of that subtotal to the total need? Divide by the draw down rate for age X (which is different for each and every age) to derive the portfolio value needed. Compare age X to age X+1, or X-1, X+2, X-2, etc. to develop a timeline to see how earlier, or later retirement, compares and what the additional savings needs may be to simply transition from accumulation at age X, to draw down at age X, using the draw down rate for age X derived from the Monte Carlo model imagined in this post. In other words, each and every calculation would be based on its' own separate Monte Carlo simulation. The model would serially connect cash flows and balances between them. This approach uses a more specifically derived method to measure and balance consumption and saving needs, a form of consumption smoothing using more specific computations that target a range of possible transition years while also connecting *specific individual* standard of living today into a specific target individual standard of living through retirement. And as that standard of living adjusts with time while working, there's a computational direct

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connection between smoothing between working and retirement years. This in contrast to using averaged (See Imagine #5 above: The Flaw of Averages) ratios or percentages of standard of living unrelated to specific situations.

11. **Imagine software that *combines all of the above*!**
12. Imagine un-imagined, or unlisted possibilities, beyond the above based on new insights simply by incorporating the above "imagines!"

Discussion.

All of the above possible modeling insights allow for rolling adjustments over time, providing insights to what those slow adjustments to length of portfolio drawdown adjustments may be, and modeling cash flows and portfolio balances with those adjustments from present age to any age in the future, even to the end of the table being used, ideally into ages 100+.

Such programming allows for viewing outcomes and plan from those possible elderly ages in reverse to retirement, and even applying the same concepts into any pre-retirement age modeling as well. **In other words, modeling as imagined above reverses the planning process of going from today into the future, to looking from the future back to today,** based on how today's decisions influences the desired future outcomes. Today's decisions ripple through the model by prudent management of the spending slope or glidepath.

All of these statistical data sets are available. All statistical sets may be metalogged (discussed further below). All the statistical sets may be incorporated into programming software that would actually model a lifetime of possibilities and compare those possibilities to other decision choices retirees may make from spending to saving. Modeling removes the term "probability of failure" and replaces it with "range of outcomes." Software such as this would have a "data cloud" where alternatives may be compared and the optimal cash flow may be determined through a lookup function using statistical data for efficient allocations (inefficient allocations would also be calculated for comparison through the programming, though not before hand as would be possible with predetermined efficient model allocations updated annually).

You see "failure" is a term referring to the iteration failure rate (the profession adopted the term "probability of failure" expressed as a percentage) of the simulation set which is made up of 1,000 or more iterations with some percentage failing to extend beyond the length of time the simulation set is cast, say 30 years, but can be over any period of time, even just 1 year in length. However, simulations are *separate* calculations that go into a model. The iteration failure rate of each calculation is not the same as the model failing. Models should calculate the range of possible actions that keeps the model viable through small spending adjustments based on the

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reality of the portfolio values over time. Wide annual swings in portfolio values can be smoothed out through various strategies the model should also incorporate. Models and calculations are two different things as explained further below.

How does today's decision affect outcomes may years in the future? The current paradigm views a single set of simulations as the "model" (one simulation) as graphed in Figure 1. Output appears similar to that graphed Figure 1; an ever-widening range of potential outcomes. Where's the "answer" to the problem of retirement income in such a graph? Most look to the range of outcomes on the right side of Figure 1, which are actually akin to "remainder values" of the simulation. The "answer" to the problem is actually on the left side of Figure 1 (where few look)! The number of simulation iterations is how the "answer" is derived.

Software as imagined in the many "imagines" above may result in solutions graphed by age. Multiple solution graphing produces results similar to those in Figure 6 (almost 200 simulations graphed).

Every data point in Figure 6 is the result of its' own stochastic simulation based on ever changing inputs (all the imagined points discussed above are inputs) from data most closely associated with each attained age in the graph (not tied to the age the simulation was started with, which results in graphing similar to that above).

Do you see the differences between the output graph in Figure 1 versus output graphed Figure 6?

Figure 6 seeks to bring in uncertainties from the science of many disciplines to illustrate the range of uncertainty when all "imagines" above are combined into a single model.
It is well known that changing the length of a simulation changes the results. Changing the allocation changes results too. A single simulation doesn't, and can't, account for changing both age and allocation within a single simulation as a retiree ages. Each of the "imagined" variables above should be done ahead of time for model portfolios (Probability Management / SIPMath) so that the optimum combination of those pre-simulated models may be selected by the programming based on each attained age to illustrate possible outcome ranges as the retiree is projected to age. Each point in Figure 6 comes from its' own Monte Carlo simulation from each individual time period and portfolio value. Note that the ever widening fan shape from Monte Carlo simulations (Figure 1) is more narrowed and focused in a model approach shown in Figure 6.

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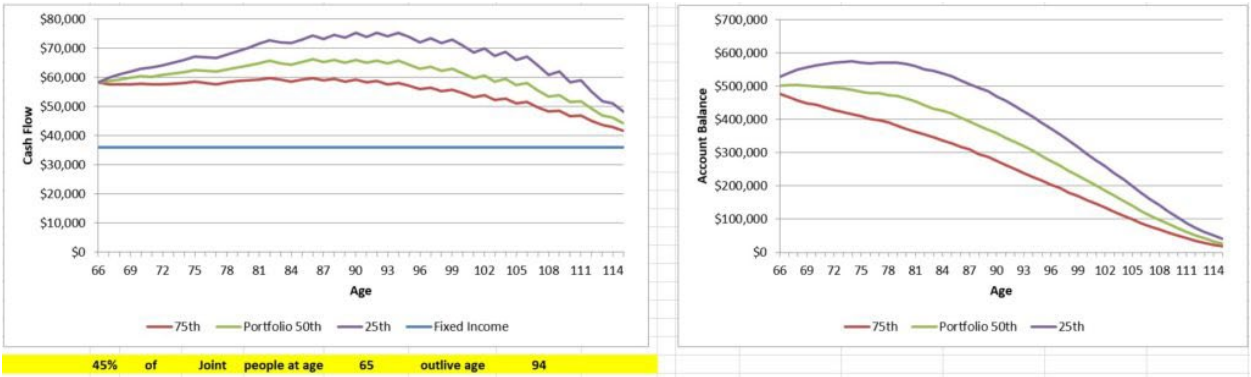

Figure 6. Cash Flows and Balances by Age through serially connected individual simulations.

Today's paradigm has TIME (number of years used in the Monte Carlo (stochastic) simulation) as the control variable to compare results. Time is NOT fixed, but changes as one ages, especially when period life tables are used for this purpose. But, TIME is not a reliable control variable with which to compare simulations. What should the control variable be for comparison of results? Iteration Failure Rate (IFR) of the stochastic simulations.

TIME arranges data backwards – counting SINCE retirement paradigm – in most of the research to date. The author has yet to come across a retiree who's trying to make today's decision based on having retired say 7 years ago for example. They're more interested in a decision based on how many years they're expected to still be spending … in other words based on expected longevity NOW, not THEN. The paradigm shift is counting years AHEAD, not behind.

In other words, it is a rolling decision. Data should be arranged with the longest time interval FIRST, going down to the shortest interval (not just a simple 30 year research period for example, or an other single and set period). That's t he paradigm shift referred to above. As one ages, the time period shortens.

Longevity in the tables is much like the bow wave in front of the boat. You don't catch the bow wave until the boat stops! As long as one is alive, there are statistical years ahead in the life tables (at least for those that go beyond age 100). When you stop, future funding of future retirement years is a moot point. It then becomes a survivor or heir plan with remaining assets (which you shouldn't outlive barring catastrophic spending) if annual computations adopt the rolling longevity approach as described in "Transition Through Old Age in a Dynamic Retirement Distribution Model." (Frank, et al, 2012b).

The fundamental takeaway is to ask yourself (as the researcher) or ask the researcher, "How would your conclusions change if you arranged your data such that longer periods come first, not last, and shorter time periods for withdrawals/drawdowns come last, not first?" Why? Because

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an longevity age-based paradigm recognizes that as one ages, time frames shorten and what should you do looking forward, not backwards, is what you're trying to decide as you continue to age and review the health of your spending plan.

The cash flow and portfolio balances in the SINGLE SET method of today is ALL simulated WITHIN that single simulation over 30 years in this example. So, aging 10 years, and then again another 10 years … how does that cash flow change between those ages? What is the range of possible choices over those years (single simulations have ever widening ranges of possibilities seen in the simulation results). The metaphor graphic for long division above shows simulation iterations for single period simulations.

The cash flow and portfolio balances as described above is a CONNECTED SERIES OF 30 SEPARATE simulations, where each of the 30 simulations represent the different time periods from the longevity tables COMBINED with selecting the optimum portfolio allocation for the time period too.

As described above, there are more than 30 time periods possible IF the retiree continues to live (or less than 30 if they don't); which is the fear today of long longevity that is tried to be solved at the beginning of retirement – uncertainty can be resolved slowly over time AS ONE AGES. This is the boat's bow wave metaphor above.

Two sets of uncertainty can be unified under the methodology described above: Probability of the Portfolio (portfolio statistics) and Probability of the Person (longevity statistics). Use of longevity provides THE ONE small thing that allows for 1) more precise calculations *by age*, 2) when to make spending adjustments, and by what magnitude, *by age*, 3) what optimized allocation to optimize supplemental retirement income *by age*, and 4) finally provides insight into remaining balances for surviving spouse and heirs *by age*. Since death is always an unknown, the *by age* component to more focused software *on age* (cash flow percentiles, and portfolio balance percentiles, ranges) provides a more focused view of how cash flow and balances may change for both the retiree at current age, but also at the retiree's future possible ages for their income while alive, or for bequests when they're not.

Retirement is fundamentally a time problem – time that should be modeled looking forward (statistical time left or remaining, counting number DOWN), instead of referencing backward anchored to a number of years *in, or since,* retirement (counting the numbers UP), or since the time a retiree retired, i.e., years since retirement. Since the mortality tables change shape internally, with age within the same table, slowly over time, those future time remaining calculations should adjust for each age as well – it's a rolling model, with a decreasing number

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of years remaining to be funded. Allocation also changes statistical shape when allocation is matched to time remaining.

Once of the goals many people imagine is having a steady income in retirement. That's ideal, but as alluded to in the "imagine" post above, it is not how retirees spend their money according to the Consumer Spending Index data from the Bureau of Labor Statistics (BLS CEX). Even while working, people often forget how their income varied … they can see this themselves by looking at their own Social Security Statement earnings history page. Spending also changes statistical shape as retirees age. In other words, all of the "imagines" above change statistical shapes as retirees age and have less time remaining, time remaining that continuously rolls ahead of each retiree simply because they're still living, albeit in ever shorter time periods. A retiree never reaches their expected longevity for present attained age, since by definition those living always have an expected longevity in the tables. It's like a bow wave on a boat – it's always there until the boat stops. A retiree doesn't need as much "principal" to fund shorter time periods (elderly years) compared to what was needed to fund longer time periods (younger retirement years). Software should make annual adjustments as one ages to slowly transition between younger and elderly years. It's those remaining years at all ages, based on attained age (looking forward), that need funding and should be modeled, not how many years since they've been retired (looking backwards).

Life is not one decision and then no more are needed into the future. Life is a series of decisions made with new information when it becomes known as we age. Modeling is much the same. As new data comes in each year, for portfolio characteristics, longevity, spending patterns, the model is redone each year. This allows for small adjustments to be made explicitly based on new calculations rippling through the model. More refined decisions are possible modeling than are possible with a set of rules of thumbs.

It's not product, but process that is missing. The profession seeks a product to solve the *lifetime* retirement income problem. But a product purchased today earlier in retirement quickly becomes out of date over time later in retirement – and thus the need to switch products (but when?) emerges. It is not a product, but a process that is needed. Modeling the process of retirement income over a retiree's lifetime is what is missing. Process should focus on 1) the retiree's *desired* individual (single or couple) standard of living and 2) the *desired* glide path of that standard (ref: BLS CEX).

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The markets always go up and down, sometimes greater than other times. Just because anybody retires, does not mean that market behavior suddenly changes. No, market sequence risk is always present and as one should expect the markets to continue with up and down swings in the future after retirement about as often and they experienced during their working years as accumulators. Yes, withdrawals do matter, however Figure 6 shows it is possible to model a range of that market behavior to calculate meaningful action, typically found to be small adjustments to spending (which tends to be a natural reaction during great market stress too) as the most meaningful adjustment to make. Models should pre-calculate at what point portfolio values suggest such small spending adjustments, both on the upside swings (e.g., when to do a house repair? or replace the auto?), as well as when to retrench spending on the downside swings and how much that new spending should be? Modeling should suggest actions ahead of time versus reacting at the moment, thus providing an ability to evaluate, in advance with better precision (2) that exists today, possible courses of action. Advisers and retirees shouldn't need to reinvent the wheel reacting to market actions. Instead they should have pre-determined more precise points with meaningful evidence based actions already established and updated annually in a Distribution Policy Statement (DiPS).

Regardless of when you retire, markets are always uncertain. When does a retiree make adjustments with poorer than expected markets come? Answer: portfolio values and spending for such situations can be calculated using the very same methodology as retirement income calculations, only in reverse to determine a target portfolio value to support a decreased spending amount ahead of the event. What affects the allocation decision the most? Answer: Time (age) which can also be pre-calculated based on the imagines above too.

Though the author's focus has been on the use of stochastic, or Monte Carlo, simulations, other methods may also be used in the determination of *each data point making up the data cloud* used in the modeling described herein. The important point is the development and use of the data cloud in order for the modeling software to discern optimum allocation selection based on age and time period coming from the inputs of longevity percentiles, draw down caps (as shown below), spending ceilings and/or floors, and other model designs.

A paradigm shift in both the profession and the software supporting the profession is needed to make the next jump in perspective and application from calculations (currently an extension of deterministic thought with a stochastic overlay to do *one calculation at a time* … even for retirees retiring at different times) to modeling which is a full embrace of incorporating data from many stochastic processes that are organized by attained age of retirees. Much of that

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metalogged data may simply be a look up function as well. Finally, planning community push back is quite the opposite of embracing evidence derived from research from our own planning profession, as well as that of other research and body of knowledge communities such as actuarial and statistical sciences mentioned above.

It is the author's hope that this paper leads to deeper thought and further exploration by others into how to apply scientific thought processes and insights from other sciences and professions to move the planning profession forward from the present limited views and approaches it currently has, possibly based on confirmation-based research rather than taking an exploratory-based or scientific method hypothesis based research approach which tends to broaden insights, findings and perspectives. The academic methodology is to disprove or duplicate prior research as well as to expand the body of knowledge in the subject area of investigation. The application of science and evidence should distill things down to fewer more refined *models*, rather than the many unduplicatable solutions apparent now that don't provide specific answers but rather *general rules and guidelines* that constantly shift with the times (e.g., is it a 4% rule or 3% rule now, or when might it be 4.5%; or what is the inflation rate to apply to that rule; or how does that/those rule(s) change with age; or how does a retiree transition to another adviser say 5 or 10 years into retirement using any of the many rules out there since the retiree's past isn't known to the new adviser (models would at least have a future range of solutions very close to those modeled in the past, and thus transition would be more known to both the retiree and adviser with them simply picking up with where the retiree is now in their model and move forward from there), etc., etc.,?

Clients are called patients in the medical profession which has more established processes, protocols, and procedures based on the embrace of a more evidence based approach deeply rooted in the application of many science disciplines. Doctors don't measure themselves in terms of production; they measure themselves in terms of patient outcomes. Our profession needs to do the same by measuring successful retiree outcomes, both as they approach, transition into, and live through, retirement.

Note that the model illustrated by prototype software in Figures 6, 7 and 8 don't do all of the "imagines" above, but just "imagine" if it did, since it already illustrates the difference between the simulation-paradigm vs the model-paradigm with just some of the "imagines" above (life table percentiles. with the fixed variable of iteration failure rate for consistent data comparisons and rolling time frames, applied)! All values are expressed in "today's" (real) dollars.

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25th percentile represents *continuous* market returns below the 50th (expected) percentile, and 75th percentile represents *continuous* market returns above the 50th percentile. [Note that these are example percentiles for illustration purposes.] Further research based on metalogged portfolio standard deviations for each portfolio would be the next "imagined" refinement to specifically make software calculate specific spending adjustments based on specific portfolio values based on current, and future, ages. These specifically selected percentiles represent results through spending flexibility where actual spending may "wiggle" over the years somewhere between the upper and lower bound (though in clinical practice, a dramatic and feared yearly swing to spending has NOT been observed). These values are specifically calculated for spending based on portfolio values representative of those percentiles. This contrasts with the practice today of estimating percentage rules of thumb adjustments to spending. Note too that there is no "failure" defined by income at or above the "fixed income" (Social Security) level.

Add another to the "imagines" above, how actual retirees really do spend (BLS CEX), as a graph of comparison to how a specific retiree (you) may be able to spend, is illustrated in Figure 7 in order to get a better idea of how your actual spending may change as you age, for very useful insights for decision making about spending versus later portfolio values (arguably bequests, also illustrated, intended or unintended). Figure 7 is the same as Figure 6, with added perspectives of spending trends with age and veiling low probability ages of living to, based on present age.

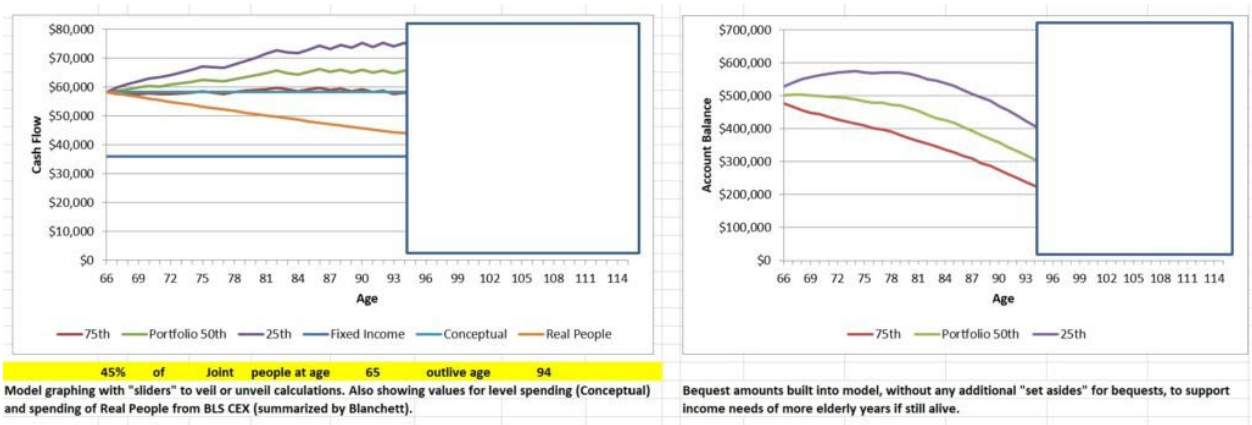

Figure 7. Spending by Cash Flow percentiles and Portfolio Balances by age.

Circling back to the spending "floor" or "ceiling" concept mentioned in Imagine #9 above, the conceptual floor would be a constant, level, spending line across the ages. However, with the insight of how retirees actually spend their money in retirement slowly decreasing with age, it makes sense to have both the "floor" or "ceiling" lines to slowly decrease in time as well,

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informed by using metalogged BLS CEX data by age. The contrast between the conceptual constant spending versus "real people" spending is graphed as an example in Figure 7 above.

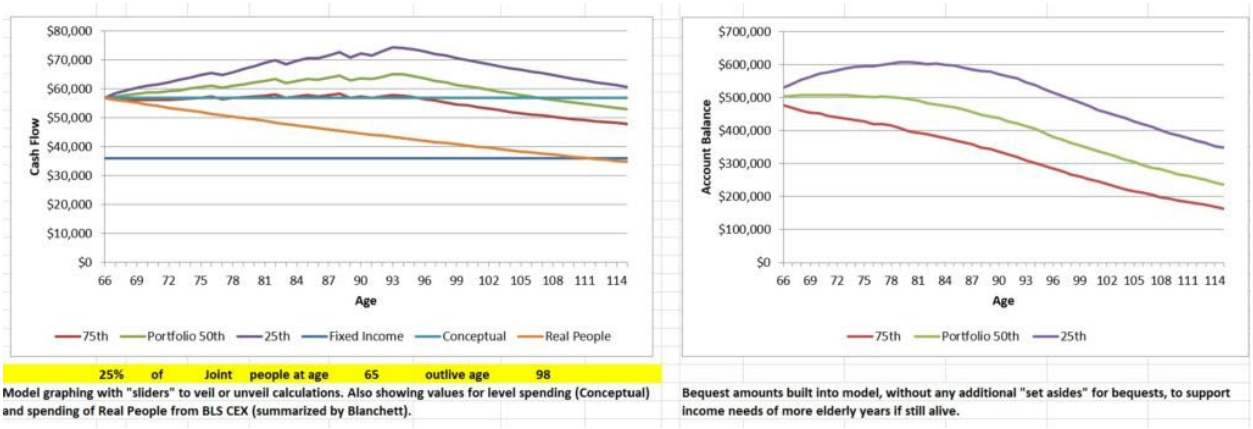

Figure 8. "Ceiling" spending applied.

Figure 8 illustrates the "ceiling" concept by adjusting the length of the model time periods starting with the 25th longevity percentile (vs starting at the 45th in the prior two graphs) adjusting down to the 5th longevity percentile by age (e.g., 25% of the age group outlives the longevity table age) and putting a spending ceiling of 7% maximum draw down rate. Figure 8 thus shows how the "slope" of spending and balances may be custom designed to each retiree's future outcome desires through a modeling approach that influences the future years much more than the near term years. This example shows that constraining spending leads to higher balances at later ages. Is constraining spending today leading intentionally, or unintentionally, to greater adviser fee retention from this insight? Or is the retiree understanding these trade offs being discussed and the retiree decides? Modeling allows for a more nuanced and dynamic conversation with retirees about the interactive and interconnected nature between retirement spending and bequests.

The longevity tables change shape with age. Adjusting the longevity percentile slowly with age in a rolling manner slowly results in time periods the retiree probably won't outlive. For example, starting with the median 50th percentile at age 60, e.g., 50% of that age group, single or joint, outlives the resulting end age), and adjusting the percentile down by 1 percentile each year as they age, leads to the 20th longevity percentile at age 90, where 20% at that age, joint or single, outlive that time period to that resulting end age. This also slowly adjusts the draw down rate, in a rolling manner, from a lower rate in younger years, to a higher rate in more elderly years. This is because the longer the withdrawal period, the lower the draw down rate. Use of the longevity tables directly connects statistical years of life to time periods for more refined

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computational purposes to allow for a smooth transition year by year for retiree spending. Unlike the RMD tables which have a bias towards a taxation agenda, direct use of the longevity tables connects spending rates with age.

More model insight discussion

Three other points. First, replacing lost survivor income at any age, either pre- or post-retirement, is like retirement income planning in that the objective is to determine the *amount* of assets (possible asset sources: life insurance, reverse mortgage, portfolio asset set aside, downsize, etc.) needed to replace that lost income, supposedly for the remainder of life, or could be for shorter periods of time. Other income sources reduce the amount needed for that replacement. Second, barring catastrophic spending, the objective to continue to have assets to support income regardless of age while alive, means there are assets remaining at attained age to fund those remaining years. This means that estate planning should be kept current to bequest those assets when that time inevitably comes to do so. This too is at any age, young or old. Such an approach is akin to buying an income annuity, for one year at at time, with the portfolio balance acting as personal mortality credits to purchase the subsequent year all the way through to the end of the longevity table in use. As long as the retiree is alive, there needs to be portfolio value reserved to support those future years from the longevity table, year by year in a rolling manner. Third, fees come from portfolio balances as do cash flows. These should be computed *separately* for each simulation iteration percentile so that higher portfolio balance iteration percentiles generate appropriate fees and cash flows for each iteration, and lower fees and cash flows for lower iteration percentile portfolio balances. Additionally, adjusting these for each age too. Each age and iteration would have its' own fee and cash flow calculation to more closely model reality of aging along with a range of potential portfolio balances as a retiree ages. These model estimates would adjust with each dynamic update of the data within the model over time, thus updating the model estimates with age too.

Speaking of fees, method of fee should be modeled appropriately as well. Net retiree income depends on the fee method as the below example graphic shows. Note the use of 4% draw down rate below is for example only to contrast the outcome of how a retiree pays their adviser fee. The actual drawdown rate would vary by age as described here in this post.

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Fee paid out of balance as AUM fee:		
Portfolio Balance	$1,000,000	
1% Annual Fee	$ 10,000	Paid out of Balance Prior to Income
Balance Post Fee	$ 990,000	
4% Net Annual Income	$39,600.00	
Annual Fee paid out of Income:		
Portfolio Balance	$1,000,000	
4% Annual Income	$ 40,000	
1% Annual Fee	$ 10,000	Fee billed directly to retiree
Net Annual Income	$ 30,000	
Net Annual Income	$ 9,600.00	Difference in billing method
4% draw down rate an example. Concept scales regardless of fee %.		

The draw down and/or fee percentages scale proportionally regardless of portfolio balance. Fees are not a constant across the model since model percentiles with higher portfolio balances will have proportionally higher fees, and vice versa for lower percentile portfolio balances. Cash flows thus differ at each model age due to what portfolio balance may be modeled by iteration percentile. This is especially true for blended fee schedules, but still true for flat percentage fee schedules as well. Finally, taxation of fees from qualified retirement plans is different between the upper and lower examples in the graph above.

The author is a planner rather than a software programmer who leads through thought experiments (a discipline coming from university physics days) supported by existing research from many disciplines already out there as well as developing some of that research by the author (Google Scholar) with working papers posted on SSRN). The application of all that research from many disciplines should be picked up by the software programming community (and requested by the planning community). All of the above "imagines" are within reach. They simply need programming that puts them all together to form a model approach versus current day single calculation approach. The profession is unaware of the potential – but waiting. The software community is unaware they should develop and supply such capability due to present software package's perceived demand, i.e., needs or desires, resulting from the existing old paradigm both communities have. Finally, planning community push back is quite the opposite of experimentation and embracing evidence derived from research. What is lacking in the financial planning community is a rigorous application of the scientific method beyond the common 30 year view, or the 60/40 stock/bond allocation as I've mentioned above (of which few 60/40 allocations are comparable to any other 60/40 allocation due to degree of efficiency of the combined components). As I've mentioned, there are other time periods and other allocations

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that come into a comprehensive model to replicate aging properly. The allocation glide path decreases equity exposure with increased age when shorter time periods are compared to longer time periods. Arranging allocation data is often reversed when viewed through the prism of years since retirement, with longer time period data following shorter time period data. But that is not how time periods fall through the prism of time arranged by age using life tables.

How does financial planning become a profession? One step is to develop standardized processes that can be calculated and audited. As it stands now, the "rule of thumb" approach using X% withdrawal rates subsequently adjusted for inflation of some amount, leads to an issue when that retiree changes advisers (due to their own choice or adviser retirement, etc.) in that the new adviser (or retiree themselves) has no point of reference as to how the retiree arrived at their current spending cash flow amount because it is based on some point in the past ("years since retirement"), neither is cash flow directly related to actual portfolio value once the retirement is put into motion. There's a disconnect between current cash flow and current portfolio value. Under a "time since retirement," …how does an adviser compare retirees who retired at 60, 65, 70, or any other age, to each other since they would all have different "times since retirement" time frames when viewed by the advisor? There is a lot of "Kentucky windage" needed under the "rules of thumb" approach when each retiree has a different time frame since they retired and thus different timing of past adjustments to get to what income they're receiving presently. The modeling methodology imagined above keeps, at all times and at all ages, current cash flows aligned with current portfolio values calculated for each age specifically since it is modeled looking forward at all points in time including ages the retiree is presently unlikely to outlive by explicit use of life tables. Updating data each year tweaks the inputs to tweak the output slowly over time, through a process I call "Dynamic Updating."

Which life table(s) to use? Any or all because each table is a measurement of a subset of the same population. For example, the Social Security tables might be viewed as the whole population (at least as far as a large part of the population receives Social Security) and thus it includes a spectrum of healthier mixed with less healthy, and annuity tables as a subset of the healthier subset of that same population. Which table represents each specific retiree sitting in front of the adviser? Again, modeling in a manner that more closely fits each retiree. Survivor income for either of a couple after death of the other is also possible by modeling the asset/insurance/reverse mortgage/annuity need to replace that lost income. For example, there's an automatic income cut when one of a couple dies. What's the lost income from that pay cut? What is the lump sum dollar amount needed to replace that loss? What is the source for that lump sum need?

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Retirement researchers tend to be "young." By "young," I mean they're still working and not yet retired themselves. By definition, retirement would end their research years. I bring this up through the observation that research from "young" researchers, tends to be biased toward viewing the retirement problem as a long-term problem; in other words, 30-year time frames biases the results because of those longer term time frames.

Why is research only over 30-year periods? Why not include shorter time periods appropriate for older retirees? Or include longer time periods for those retiring in their early 60's, or forced to retire in their late 50's or even earlier? How does the current paradigm transition from longer to shorter simulated time periods? Retirement planning is not a rolling period of 30-year simulations, implying retirement never ends; it eventually does.

Modeling shouldn't be over a single time period either. Shorter time frames produce different results compared to longer time frames; results which are not apparent since researchers are not considering shorter time frames that would apply to more elderly retirees in their research. Statistically, there is a larger number of retirees with less than a 30-year time frame; and a small subset with longer than 30-year time frames. So, a 30-year time frame really is applicable for a very small subset of retirees when viewed through the lens of longevity tables. Why would a 75-year-old (or older) use a 30-year retirement period? You can prove this time frame bias to yourself by running shorter retirement periods. 1) You get different results than you do from longer periods. 2) You're questioning yourself in that the shorter period ends at an earlier age – one that you may expect to outlive now – so you throw out that different result as "not applicable." This makes the author's points – the reader's bias is based upon retiree (or researcher in this segment) age today; not based on applying a future time frame applicable to a retiree when they're older where that shorter period takes them to an older age you can't imagine outliving!

Practitioners in the profession also have a client base with a bell curve with the median age near their own age – and since they're not retired, their views are also biased to longer terms that are appropriate for younger retirees (those in their 60's and early 70's), but don't really apply to more elderly retirees (who may not be in their client base yet). Thus, researcher and practitioner focus tend to *lack a model that transitions* retirees from 30 years of retirement, into 25 years, then into 20, 15, 10 and even 5-year terms. In fact, models should transition annually for smoother transitions between ages in a methodical manner that *directly connects* draw down, and *simultaneously compares* alternatives, to present balance, allocation and age between each point throughout the model. There is no model approach existing today that smoothly transitions,

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within the model, from longer to shorter retirement periods. There's no model that applies to more elderly retirees today; yet there are younger and older retirees *coexisting* along the whole spectrum of ages. *How does a retiree transition, incrementally year by year by year, from longer time frames, into shorter time frames, that apply to more elderly retirees as they age?* There is no modeling software that shows how a younger retiree today may age into that older retiree. Nor is there modeling software today that shows that older retiree today, how to transition into that even older retiree later on. There's no modeling software to day to evaluate and assist that even older retiree in their decision making into even older ages for them either. Again, different retiree ages *coexist at the same time.* Programmers and practitioners shouldn't just be looking at those retirees in their 60's or 70's, but also those who are, or will be, in their 80's, 90's or 100's too. More importantly, how to transition year by year from any age to each age thereafter? Software that models that aging transition is a practical guide for making transitional decisions slowly over time via "dynamic updating."

The above may seem "too complicated." Modern surgery, for example, has advanced considerably over the decades unhindered by "that's too complicated" thoughts. Computer processing power and software programming has come a long way in the past couple of decades and can manage the above imagines in a combined and fluid manner. Retirement too is a process that is more complicated than one-at-a-time single-period simulations or calculations viewed alone as answers. Alternatives can be compared by programming and optimal solutions modeled. and adjusted from there, instead of doing this manually one by one through one at a time simulations over single periods as mentioned above. It is time the profession combines present research insights into a unified model, that incorporates aging directly as well, to advance the profession further.

Epilogue

This paper sought to expand the retirement income planning profession's view of income planning by bringing a more focused view of longevity nuances so that practitioner's and software programmers may advance the profession's capability to provide more focused insights to a retiree's future ages. This goal, as opposed to the present-day capability which is based on a less focused cash flows and balances beyond a very short time; the simulation solution is only looking into the near future, but creates the illusion that future years are clear too. Those future years are not clear. This paper seeks to provide more focused standards using statistics in many key areas the impinge on retirement income planning: *efficient* allocation statistics (with ability

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to run simulations with any set of allocation statistics to contrast with efficient results), longevity statistics meaning percentiles of ages that current age retirees may outlive, and consumer spending statistics. The result will be to professionalize both the planning and software programming professions with better focus on a range of possible statistical outcomes *by age.*

The author challenges the reader to adjust their paradigm to data cloud modeling rather than try to squeeze all of the above into the present single, one by one by one, simulation paradigm where different allocations are compared one by one; and different time frames are compared one by one; and transitions over time (that models aging) of both allocations and time frames at the same time are not. A data cloud approach can easily choose between data points since the simulations have already been done. Why keep repeating redundant simulations during the course of the year as if the range of iteration outcomes may suddenly change given the same data inputs? The data cloud changes when the data changes from year-to-year data reviews.

This isn't meant to diminish the research work of all those who have contributed to the body of knowledge. This acknowledges those key steppingstone insights and extends, and expands on, those with a nudge towards lessor unexplored directions via an important, and arguably necessary, next step shift in paradigm to advance the profession and its' processes further into more refined and advanced modeling.

Only that which is untried remains unknown. That which is newly tried often leads to unimagined insights.

Conclusion

Researchers need to sharpen their thinking in a number of areas related to retirement income research:

- Derive *efficient and optimized* allocations with which to obtain portfolio statistics that are then optimized themselves – this step is what gets the money invested working as hard as it can.
- Evaluate a range of *optimized* portfolio allocations with which to discern which allocation corresponds to an age *range* retirees age through.
- Evaluate a large number of time frames with which corresponds to the retirees attained age and strategically determined longevity percentile with which determines an end age, less and less likely to be outlived, *as the retiree ages.*

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- Metalogged data for all the statistical sets, including consumer spending statistics, ideally with certain key expenses metalogged separately, e.g., medical expenses, long term care expenses, and perhaps travel expenses which is also a popular spending category. All to see at what ages these expenses tend to be and percentiles to discern at what age(s) transitions between categories occur.
- Software programmers should develop software data clouds with which to incorporate the statistical data derived above so that cash flows *between each age* better determine a range of portfolio balances *at each age* (based on serially connecting cash flow and balance percentiles).
- All of the above to replace single data set simulations, where time is just one period (with others not considered, or even a sequential connection between time periods); single allocation considerations (without considering others as well).
- Aging is a serially connected set of cash flows and balances and present-day simulations don't come at all close to modeling aging with all of the above points in this paper in mind.
- Transition computer processing power from running redundant computations/simulations, to pulling data from all the statistical data sets that corresponds to each age as one ages.
- Planners are not working with just one retiree; they work with many retirees. Each retiree is unique in that they come in different ages. Each retiree is similar in that they all age into future ages, and the aging of the younger retirees overlaps into the aging of the older retirees, regardless of the age younger or older retirees are.
- What may be different is their bequest or consumption goals. The yin and yang of those competing goals may be better evaluated by the retiree when spending ceilings, and/or spending floors are considered to meet the retiree's goals. Since these goals are perceived to be farther in the future, cash flows and balances need to be serially connected to keep those two goals aligned with the retiree's wishes.
- However, especially in the circumstances of couples, early death may change the spending goal of the survivor and being able to "see" future balances that are in place to help replace lost income (Social Security has an automatic pay cut in that the low benefit "goes away") assists in developing a plan to replace what present assets may not be able to replace on their own.

Modeling won't predict the future, but it is useful to make decisions within a range of statistical possibilities, and even more useful when statistical data can be arranged to correspond to age and aging. Data clouds of data (see Figure 5) redirect computer processing power to modeling since each data point is already precomputed and archived for modeling purposes.

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Endnotes

1. "The statistician George Box said that 'All models are wrong, but some are useful.' Dwight Eisenhower, supreme Allied Commander in WWII, said that 'Plans are nothing; planning is everything.' I say that models are nothing; modeling is everything, because it will help you … figure out what is going on here."

   https://www.probabilitymanagement.org/blog/2020/12/01/the-axiomatic-fallacy-fallacy The Axiomatic Fallacy Fallacy, December 1, 2020. Quote from Dr. Sam L. Savage, Executive Director of Probability Management.org, a 501(c)(3) nonprofit devoted to making uncertainty actionable.

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Appendix 1. Example efficient allocations with characteristics and asset class data incorporated.

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Target Band

The Risk-Based Portfolio was selected from this list of Portfolios, based upon the risk assessment. The Risk Band is comprised of the portfolio(s) that could be appropriate for you, based upon the Risk-Based Portfolio indicated. The Target Portfolio was selected by you. Refer to the Worst 1-Year Loss and Standard Deviation columns in the chart below to compare the relative risks of your Current Portfolio to the Target Portfolio.

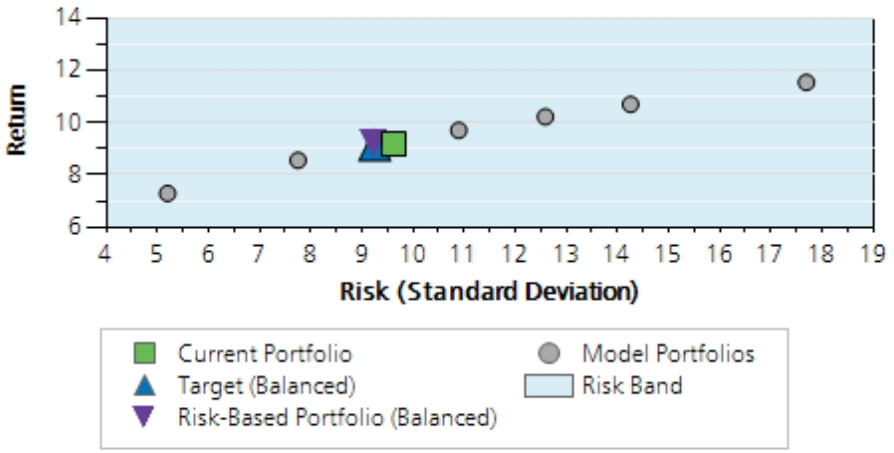
Portfolios	Name	Cash	Bond	Stock	Alternative	Fixed Index	Average Return	Worst One Year	Standard Deviation
	Defensive	0.50%	79.50%	18.00%	2.00%	0.00%	7.29%	-3.35%	5.20%
	Conservative	0.50%	59.50%	38.00%	2.00%	0.00%	8.56%	-12.73%	7.75%
▼ ▲	Balanced	0.50%	49.50%	47.00%	3.00%	0.00%	9.15%	-17.41%	9.25%
■	Current	0.52%	47.04%	49.32%	3.12%	0.00%	9.22%	-18.44%	9.61%
	Moderate	0.50%	39.50%	57.00%	3.00%	0.00%	9.71%	-22.10%	10.90%
	Moderately Aggressive	0.50%	29.50%	67.00%	3.00%	0.00%	10.23%	-26.80%	12.59%
	Aggressive	0.50%	19.50%	76.00%	4.00%	0.00%	10.71%	-31.47%	14.26%
	Highly Aggressive	0.50%	0.00%	95.50%	4.00%	0.00%	11.55%	-40.65%	17.70%

Risk Band ■ Current ▼ Risk-Based ▲ Target

Return vs. Risk Graph

When deciding how to invest your money, you must determine the amount of risk you are willing to assume to pursue a desired return. The Return versus Risk Graph reflects a set of portfolios that assume a low relative level of risk for each level of return, or conversely an optimal return for the degree of investment risk taken. The graph also shows the position of the Risk Band, Target, Risk-Based, and Custom Portfolios. The positioning of these portfolios illustrates how their respective risks and returns compare to each other as well as the optimized level of risk and return represented by the Portfolios.

This graph shows the relationship of return and risk for each Portfolio in the chart above.



See Important Disclosures section in this Report for explanations of assumptions, limitations, methodologies, and a glossary.

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IMPORTANT DISCLOSURE INFORMATION

Asset Class	Historical Return Index
U.S. Total Stock Market	CRSP Deciles 1-10 Index (1972-1978). Russell 3000 TR USD (1979-2020).
U.S. Large Growth Stocks	Fama/French US Large Growth Index (ex utilities)(1972-1978). Russell 1000 Growth TR USD (1979-2019).
U.S. Large Neutral Stocks	S&P 500 Index (1972-1978). Russell 1000 TR USD (1979-2019).
U.S. Large Value Stocks	Fama/French US Large Value Index (ex utilities) (1972-1978). Russell 1000 Value TR USD (1979-2020).
U.S. Small Growth Stocks	Fama/French US Small Growth Index (ex utilities) (1972-1978). Russell 2000 Growth Index (1979-2019).
U.S. Small Neutral Stocks	CRSP Deciles 6-10 Index (1972-1978). Russell 2000 TR USD (1979-2020).
U.S. Small Value Stocks	Fama/French US Small Value Index (ex utilities)(1972-1978). Russell 2000 Value Index (1979-2019).
International Total Stock Market	MSCI World ex USA NR USD (1972-1994), MSCI World ex USA IMI NR USD (1994-2019)
International Large Growth Stocks	MSCI World ex USA NR USD (1972-1974). MSCI World Ex USA Growth NR USD (1975-2019).
International Large Neutral Stocks	MSCI World ex USA NR USD (1972-2019).
International Large Value Stocks	MSCI World ex USA NR USD (1972-1974). MSCI World Ex USA Value NR USD (1975-2020).
International Small Growth Stocks	Dimensional International Small Cap Index (1972-1989). S&P Developed Ex US Small Growth TR (1990-1994). MSCI World Ex USA Small Growth NR USD (1995-2019).
International Small Neutral Stocks	Dimensional International Small Cap Index (1972-2000). MSCI World Ex USA Small Cap NR USD (2001-2020).
International Small Value Stocks	Dimensional International Small Cap Index (1972-1981). Dimensional International Small Cap Value Index (1981-1994). MSCI World Ex USA Small Value NR USD (1995-2019).
Emerging Markets Total Stock Market	MSCI Pacific Ex Japan NR USD (1972-1987). MSCI EM GR USD (1988-1998). MSCI EM NR USD (1999-2020).
Emerging Markets Large Value Stocks	Fama/French US Large Value Index (ex utilities) (1972-1978). Russell 1000 Value TR USD (1979-2020).
U.S. Short Government Bonds	IA SBBI US 1 Yr Trsy Const Mat TR USD (1972-1977). BofAML US Treasuries 1-3 Yr TR USD (1978-1982). BofAML US Trsy/Agcs AAA 1-3 Yr TR USD (1983-2019).
U.S. Intermediate Government Bonds	IA SBBI US IT Govt TR USD (1972-1972). Barclays US Government TR USD (1973-2019)

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IMPORTANT DISCLOSURE INFORMATION

Asset Class	Historical Return Index
U.S. Long Government Bonds	IA SBBI US LT Govt TR USD (1972-1972). Barclays US Government Long TR USD (1973-2019).
U.S. Short Investment Grade Bonds	50% IA SBBI US 1 Yr Trsy Const Mat and 50% IA SBBI US IT Govt. (1972-1984), 50% IA SBBI US 1 Yr Trsy Const Mat and 50% Citi WGBI 1-5 Years (hdg) (1985-1986), 50% BofA ML 1-3 yr US Corp/Govt Index, and 50% Citi WGBI 1-5 Years (hdg) (1986-2020)
U.S. Intermediate Investment Grade Bonds	IA SBBI US IT Govt TR USD (1972-1972). Barclays US Govt/Credit TR USD (1973-1975). Barclays US Agg Bond TR USD (1976-2019).
U.S. Long Investment Grade Bonds	IA SBBI US LT Corp TR USD (1972-1972). Barclays US Long Credit TR USD (1973-2019).
U.S. Short Municipal Bonds	IA SBBI US 1 Yr Trsy Const Mat TR USD (1972-1986). BofAML US Corp&Govt 1-3 Yr TR USD (1987-2019).
U.S. Intermediate Municipal Bonds	IA SBBI US LT Corp TR USD (1972-1980). Barclays Municipal TR USD (1981-2019).
U.S. Long Municipal Bonds	U.S. 30-day Treasury Bills (1926-2016)
U.S. Inflation-Protected Bonds	IA SBBI US LT Govt TR USD (1972-1997). Barclays US Treasury US TIPS TR USD (1998-2019).
U.S. High-Yield Bonds	IA Barclays US HY Corporate Bonds (1972-1983). Barclays US Corporate High Yield TR USD (1984-2019).
Global Short Bonds	IA SBBI US IT Govt TR USD (1972-1984). Citi WGBI 1-5 Yr Hdg USD (1985-2019).
Global Intermediate Bonds	IA SBBI US IT Govt TR USD (1972-1984). Citi WGBI Hdg USD (1985-2019)
Real Estate	FTSE NAREIT All Equity REITs TR USD (1972-1986). DJ US Select REIT TR USD (1987-2020).
Cash & Cash Alternatives	IA SBBI US 30 Day TBill TR USD (1972-1977). BofAML US Treasury Bill 3 Mon TR USD (1978-2020).
Commodities	S&P GSCI TR USD (1972-1990). Bloomberg Commodity TR USD (1991-2019).
Market Neutral	U.S. 30-day Treasury Bills (1926-2016)
Managed Futures	U.S. 30-day Treasury Bills (1926-2016)
Reinsurance	U.S. 30-day Treasury Bills (1926-2016)
Alternative Lending	U.S. 30-day Treasury Bills (1926-2016)
Diversified Alternatives	U.S. 30-day Treasury Bills (1926-2016)
Conservative Allocation	80% IA SBBI US IT Govt TR USD, 20% MSCI World NR USD (1972-1972). 80% Barclays US Govt/Credit TR USD, 20% MSCI World NR USD (1973-1975). 80% Barclays US Agg Bond TR USD, 20% MSCI World NR USD (1976-2019)

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IMPORTANT DISCLOSURE INFORMATION

Asset Class	Historical Return Index
Moderate Allocation	50% IA SBBI US IT Govt TR USD, 50% MSCI World NR USD (1972-1972). 50% Barclays US Govt/Credit TR USD, 50% MSCI World NR USD (1973-1975). 50% Barclays US Agg Bond TR USD, 50% MSCI World NR USD (1976-2019)
Aggressive Allocation	20% IA SBBI US IT Govt TR USD, 80% MSCI World NR USD (1972-1972). 20% Barclays US Govt/Credit TR USD, 80% MSCI World NR USD (1973-1975). 20% Barclays US Agg Bond TR USD, 80% MSCI World NR USD (1976-2019)
Global Total Stock Market	MSCI World NR USD (1972-1994), MSCI ACWI IMI NR USD (1994-2019)
Global Total Developed Stock Market	MSCI World NR USD (1972-1994), MSCI World IMI NR USD (1994-2019)
Other Assets	S&P 500 (Price Return) (1972-2019)
Fixed Index	
3% Fixed	

Actual advisory fees under a current portfolio may be higher or lower than the fee input in a specific calculation. Advisory fees may vary. Input of an advisory fee will result in the decrease of a simulated portfolio's overall value.

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